Outcome of surgically treated fractures of the condylar process by an endoscopic assisted transoral approach

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Abstract: Purpose Fractures of the condylar process are frequent. Ideal management of these fractures, as discussed in the literature, is controversial. Some recent meta-analyses have favored open reduction and internal fixation using various approaches. A strictly transoral approach has been described to minimize scarring and risk of facial nerve injury but has restricted visibility. This retrospective study analyzed outcomes of patients with unilateral mandibular condyle fractures who were treated by open reduction and internal fixation through an endoscopic-assisted transoral approach. Materials and Methods This study included 40 patients who were operated on from January 2015 through December 2016. All patients underwent surgery for a condylar process fracture using an endoscopic-assisted transoral approach. Fracture classification, demographic, and outcome data were collected. Results Most condylar process fractures were caused by falls from a height less than 3 m. Most were condylar base fractures and classified according to Spiessl and Schroll as Classes I and II. Sixteen patients showed a preoperative malocclusion, whereas 2 patients showed a slight postoperative malocclusion. In cases in which only 1 plate could be placed, the proximal fragment was shorter. A higher Spiessl and Schroll class showed a tendency toward longer operation times. For postoperative outcomes, 1 case of temporary facial palsy was the worst complication (2.5%), 2 cases exhibited minimal occlusal interference (5%), and 1 case exhibited a deviated mouth opening (2.5%). Ramus height was restored in all cases. No chronic pain was found in any cases.

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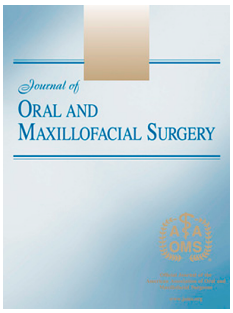

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Abstract

Aim of the study

Fractures of the condylar process are frequent. Ideal management of these fractures, as discussed in literature, is controversial. Some recent meta-analyses favour open reduction and internal fixation using various approaches. A strict transoral approach is described to minimise scarring and the risk of facial nerve injury but has restricted visibility.

This retrospective study analyses outcomes of patients with unilateral mandibular condyle fractures who have been treated by an open reduction and internal fixation through an endoscopic assisted transoral approach.

Materials and Methods

This study included 40 patients who were operated on between January 2015 and December 2016. All patients were operated for a condylar process fracture using an endoscopic assisted transoral approach. Fracture classification, demographic, and outcome data were collected.

Results

Most condylar process fractures were caused by falls of under 3 m. The majority were condylar base fractures and classified after Spiessl and Schroll as classes I and II. Sixteen patients showed a preoperative malocclusion, whereas in just 2 cases a slight postoperative malocclusion was found. In cases where only 1 plate could be placed, the proximal fragment was shorter. With higher Spiessl and Schroll classification, a tendency towards longer operation times was noted. Postoperative outcomes revealed 1 temporary facial palsy as the worst complication (2.5 %), 2 cases with a minimal occlusional interference (5 %) and a deviation in mouth opening in 1 case (2.5 %). The ramus height was restored in all cases. No chronic pain could be found in any of the cases.

Discussion

It is feasible to treat condylar process fractures in a safe manner by a transoral approach with endoscopic assistance and angled instruments without facial scarring and at a low complication rate. The endoscope improves the reduced visibility of the transoral approach, although a learning curve is necessary. This applies especially to dislocated fractures or to fractures with a short proximal fragment.

Introduction

Facial fractures make up a substantial proportion of all trauma cases, whereas mandible fractures occur in up to 45 % of the cases [1-3]. Condylar process fractures are common fractures of the mandible, accounting for 25 – 35 % of these fractures [4, 5]. Several studies have analysed outcomes of open versus closed treatment using different classification systems for fractures of the condylar process, complicating comparisons and meta-analyses. As a result AOCMF published a classification system in 2014, which will hopefully facilitate future comparisons [6].

Ideal management of these fractures is still a controversial discussion in the literature [7]. Closed treatment (CT) was favoured for decades, as it is less invasive and thought to have no operative risks [8], although long-term complications may include malocclusion, pain, loss of vertical height, and arthritis [9] (Fig. 1).

In recent times, some meta-analyses seem to favour open reduction and internal fixation (ORIF) [10, 11]. In cases with dislocation and head displacement, surgical treatment is especially favoured. ORIF allows anatomic reduction and immediate functional movement, and various approaches have been described [12-14]. A strict transoral approach is described to minimise scarring and the risk of facial nerve injury [15].

Endoscopic assistance through an oral approach is thought to improve visibility in this narrow surgical field, although the screws were often fixed through an additional transbuccal approach [16].

This retrospective study analyses epidemiological data and outcomes of patients with unilateral mandibular condyle fractures who have been treated by ORIF through a transoral approach.

Material and Methods

The clinic's information system was searched for patients who were treated for a unilateral extracapsular mandibular condyle fracture using an endoscopy assisted ORIF through a strict transoral approach from January 1, 2015 to December 31, 2016. All patients had to be dentate for control of the occlusion. Pre- and postoperative 3D imaging was available. Bilateral mandibular condyle fractures, edentulous patients, and missing medical data were excluded. Out of 54 patients, 40 cases met all inclusion criteria (Fig. 2). Medical data from follow ups at 6 weeks, 3 months, and 6 months were collected. Fractures were classified by Loukouta et al. [17], Spiessl and Schroll [18] and the new comprehensive AOCMF classification [6].

As primary outcomes were defined fracture classification, outcomes as occlusion, postoperative mouth opening and complications as malocclusion, vertical height loss,

deviation in mouth opening, damage to the facial nerve or chronic pain (medical data [anamnesis and clinical findings] were searched for pain in the facial region, temporomandibular joint pain or pain on mandibular movement). Secondary outcomes were measurement of fragment length, duration of elastic intermaxillary fixation, number of osteosynthesis plates and operation times.

Informed consent was obtained, as was ethical approval from the responsible ethics committee at KEK Zürich (file sign: 2015-0423). The study followed the Declaration of Helsinki's guidelines and ethical principles for conducting medical research with human subjects.

Statistical analyses were performed using Excel software (Microsoft Corporation, Redmond, WA, USA) and R software (R Foundation, Vienna, Austria).

Pre- and Postoperative Radiological Evaluation:

For the pre- and postoperative evaluation of fracture classification, ramus height loss, and fragment length, the clinical Picture Archiving and Communication System (PACS) was searched (Fig. 3 – 5). The software used was either Synedra View (Synedra Information Technologies GmbH, Innsbruck, Austria) or ICIS View (Agfa HealthCare, Agfa-Gevaert, Mortsel, Belgium). Measurement of the proximal fragment, which is the distance from the fracture line to the upmost part of the head, was done on the posterior border (prospective area of the osteosynthesis plate) in the coronal and parasagittal plane (Fig. 6). No orthopantomogram (OPT) was available, hence 3D imaging was performed preoperatively. Therefore, the measurement of the ramus height loss had to be adapted to the method described by Eckelt et al. [13]. The ramus height was measured on the posterior edge of the ramus in the coronal and parasagittal plane and on the fractured and non-fractured sides.

Surgical protocol:

Perioperatively 2.2 gr of Co-Amoxicillin was applied intravenously. Then 15 mL of Carbostesin 0.25 % with 1:100'000 adrenaline (Aspen Pharma Schweiz GmbH, Baar, Switzerland) was infiltrated thoroughly as the local anaesthesia within the fractured area for fluid tissue dissection and vasoconstriction. Then, dissection by a diathermic needle on the mandibular ramus, with subsequent blunt dissection. Insertion of a 30° angled endoscope to inspect and reduce the fracture followed (Fig. 7 - 9). The osteosynthesis on the dorsal ramus border was primarily done with a Zygomatic DCP® 2.0 plate with 4 - 6 holes (Synthes GmbH, Oberdorf, Switzerland) (Fig. 10). Then, the osyteosynthesis with a Synthes adaptor plate 2.0 with 4 – 5 holes followed (Fig. 11 + 12). When the fixation area on the proximal fragment was lacking, only the Zygomatic DCP plate on the dorsal edge was applied. Haemostasis and wound closure completed the intervention.

Postoperative protocol:

Intermaxillary fixation (IMF) screws remained in situ and were either studded with elastics, or not, as the surgeon recommended. Patients remained hospitalized until the swelling had decreased. Elastic IMF was stopped in the outpatient phase when correct occlusion was achieved. Postoperative radiological imaging was performed in all cases for quality control by CBCT (Fig. 13 – 14).

A prophylactic antibiotic regimen with Co-Amoxicillin was continued for 7 days.

Results

Of the 40 patients, 29 were male (73 %) and 11 were female (27 %), corresponding to a male : female ratio of 2.6 : 1. The right side was fractured in 20 cases (50 %) and the left side was likewise fractured in 20 cases (50 %). The mean age was 34 years (median: 30; range 16 to 79).

Most condylar process fractures were caused by falls of under 3 m (15 cases; 38 %), followed by incidents of violence (9 cases; 23 %), bicycle accidents (8 cases; 20 %) and sport injuries (6 cases; 15 %).

Eleven fractures were condylar neck type fractures (28 %), while the majority were condylar base fractures (29 cases; 72 %). In 20 cases no additional fractures occurred (50 %). The most common additional fracture sites were paramedian ones (right side: 10; left side: 6).

Fracture classifications after Spiessl and Schroll [18] for condylar process fractures with and without concomitant mandibular fractures are shown in Tables 1 and 2. This classification can be correlated with fragment length. Figure 15 demonstrates that short proximal fragments show a tendency to higher Spiessl and Schroll classifications.

Fragmentation, sideward displacement, angulation, head displacement, and loss of ramus height according to the AO classification [6] are shown in Table 3 for all fractures and subdivided for individual condylar process fractures of the mandible. Fifteen patients showed no loss of vertical ramus height (38 %), 15 showed a loss of 1 mm (38 %), 9 had a loss of 2 mm (23 %) and 1 patient lost 3 mm. Sixteen patients showed a preoperative malocclusion (40 %). No correlation between a loss of vertical ramus height and malocclusion was found. Also no correlation of vertical ramus height loss to the classifications according to Spiessl and Schroll, nor to the fragment length could be found.

In 32 cases, it was possible to place 2 plates in the proximal fragments. These fragments measured between 18 and 48 mm (mean: 30.6 mm; median: 31 mm). In 8 cases, just 1 plate could be placed, and these fragments measured between 18 and 24 mm (mean: 23.4 mm; median: 24 mm) (Fig. 16).

The mean operation time for condylar process fractures without concomitant fractures was 126 min (median: 115 min; minimum: 45 min; maximum: 260 min), with concomitant fractures, 158 min (median: 145 min; minimum: 45 min; maximum: 500 min). No significant correlation was found between operation time and fragmentation, sideward displacement, angulation, head / fossa displacement, and loss of ramus height. Analysing the operation times for individual condylar process fractures and classification according to Spiessl and Schroll, no significant differences were found, but a tendency towards higher operation times with ascending classification levels (Spiessl / Schroll I: 45 – 187 min; II: 65 – 200 min; III: 75 – 170 min; IV: 85 – 120 min; V: 260 min) was revealed (Fig. 17). A tendency towards longer operation times with decreasing fragment length was also found (Fig. 18).

Postoperative outcomes revealed 1 temporary facial palsy as the worst complication (2.5 %). In 2 cases (5 %) a minimal occlusional interference persisted; in 1 case (2.5 %), there was a deviation in the mouth opening. The ramus height was restored in all cases. No chronic pain could be found in any of the cases. As result of the strict transoral approach, no extraoral scarring occurred. The mouth opening ranged from 8 to 55 mm (mean 32.6 mm; median 34 mm). Preoperative mean mouth opening was 23.7 mm. Elastic IMF was implemented from 0 to over 2 weeks (5 cases 0 days MMF [12.5%]; 7 cases 1 – 7 days [17.5%]; 15 cases 8 – 14 days [37.5%]; and 13 cases > 14 days [32.5%]).

Discussion

The purpose of this study was to analyse the outcome of endoscopic assisted surgically treated mandibular condyle fractures. The treatment was managed through a strict transoral approach.

Gender distribution showed an involvement of nearly 75 % male patients, which is consistent with other literature [19]. Most condylar fractures in our study resulted from falls of under 3 m, followed by incidents of violence, and bicycle accidents. In literature, falls, violence, and road traffic accidents are also listed as the most common causes of fractures of the condylar process [20].

No malocclusion was found in 15 cases in our study, even when a loss in ramus height occurred. The authors think this is due to dentate patients, a finding which is consistent with literature [20].

The mean operation time was 2 hours [19], which corresponds to a demanding operation technique. No correlation could be found between operation time and fracture classification, although a slight tendency towards longer operation times with higher Spiessl and Schroll classifications was noted [18] (Fig. 17). These data were collected from 2015 to 2016 as our department implemented this new technique in our hospital. The authors of this study believe

this finding is due to the learning curves of the different surgeons. Future studies will hopefully show, wether the operation time will decrease with increasing experience.

The length of the proximal fragment also affects the operation technique and time. A shorter proximal fragment length correlates to a longer operation time (Fig. 18). With cases in which just one plate could be placed in the proximal fragment, the fragments were shorter overall (Fig. 3). The duration of the elastic IMF was usually longer in these cases (8 to > 14 days) with exception of one case (7 days).

This technique allows restoration of ramus height and proper occlusion in a reliable manner. No extraoral scarring occurs. Although some restriction in the mouth opening was reported, the mean mouth opening was 32.6 mm. This is lower than described in literature [21]. This might be due to early dropouts after surgery or patients refusing physiotherapeutic treatment. No correlation could be found between a longer duration of elastic IMF and a restricted mouth opening.

Although the endoscopic procedure is described in literature as having a lower occurrence of facial nerve palsy [14], 1 case was reported (2.5 %). This palsy affected the frontal and orbital branch, it was temporary and resolved after 3 months of time. In the literature, facial nerve palsies of 0 – 21 % are reported, and in overall studies the rate is about 5.8 % [10].

Otherwise, no long-term complications were noticed in this study. At the same time, long-term complication rates of up to 23 % are described in literature [19].

A downside of the study was its retrospective character and quite small number of cases. Studies with a bigger caseload and done in a prospective manner and, if feasible, with a closed treatment control group should be conducted in order to assess the quality and advantages of this approach further.

Conclusion

It is feasible to treat condylar process fractures in a safe manner by a transoral approach with endoscopic assistance and angled instruments without face scarring and at a low complication rate. The endoscope improves the reduced visibility of the transoral approach, although a learning curve is necessary. This applies especially to dislocated fractures or to fractures with a short proximal fragment.

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Figure legends

Fig. 1: Clinical presentation with impaired mouth opening, deviation to the fractured side (left) and derangement of the occlusion.

Fig. 2: Patient enrollment.

Fig. 3: 3D reconstruction of a condylar process fracture on the left side.

Fig. 4: Coronal plane of a condylar process fracture on the left side.

Fig. 5: Parasagittal plane of a condylar process fracture on the left side.

Fig. 6: Measurements of the proximal fragment in the coronal and parasagittal plane.

Fig. 7: Instruments: different collum hooks, mouth spreader, sleeve for the endoscope, DCP and adaptor plates, wide and long retractors and a long “claw” (from left to right).

Fig. 8: Head light.

Fig. 9: Intraoperative view through the endoscope on the fracture.

Fig. 10: Intraoperative view through the endoscope after reduction and osteosynthesis with the dorsal DCP plate.

Fig. 11: Intraoperative view through the endoscope after osteosynthesis with the anterior adaptor plate.

Fig. 12: Final intraoperative view through the endoscope after reduction and osteosynthesis before closing the wounds.

Fig. 13: Intraoperative radiological control in the coronal plane.

Fig. 14: Intraoperative radiological control in the parasagittal plane.

Fig. 15: Box plots demonstrating the correlation of fragment length and classification according to Spiessl and Schroll (class I to V).

Fig. 16: Box plots demonstrating the correlation of fragment length and plates.

Fig. 17: Box plots demonstrating the correlation of operation time and classification according to Spiessl and Schroll (class I to V).

Fig. 18: Linear regression demonstrating the correlation of fragment length and operation time.

Table legends

Spiessl/Schroll I	14
Spiessl/Schroll II	16
Spiessl/Schroll III	5
Spiessl/Schroll IV	3
Spiessl/Schroll V	2

Table 1: Classification by Spiessl and Schroll [18] with concomitant mandibular fractures (n=40).

Spiessl/Schroll I	6
Spiessl/Schroll II	7
Spiessl/Schroll III	3
Spiessl/Schroll IV	3
Spiessl/Schroll V	1

Table 2: Classification by Spiessl and Schroll [18] without concomitant mandibular fractures (n=20).

		with concomitant mandibular fractures (n=40)		condylar process only (n=20)	
fragmentation	none	30	75%	15	75%
	minor	10	25%	5	25%
sideward displacement	none	14	35%	6	30%
	partial	11	28%	5	25%
	full	15	37%	9	45%
angulation	0°	11	28%	6	30%
	0 - 5°	26	65%	12	60%
	>45°	3	7%	2	10%
head / fossa displacement	none	35	88%	16	80%
	displacement	3	7%	2	10%
	dislocation	2	5%	2	10%
loss of ramus height	none	15	37%	7	35%
	1 mm	15	37%	8	40%
	> 1 mm	10	26%	5	25%

Table 3: Fracture classifications adapted to the AO classification system [6].

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